NASA Facts

National Aeronautics and
Space Administration

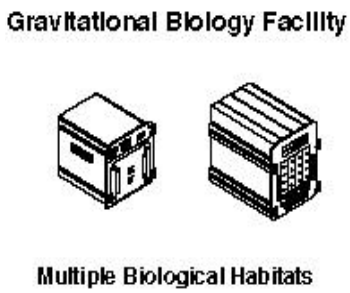
Ames Research Center
Moffett Field, California 94035
ARC-97-04

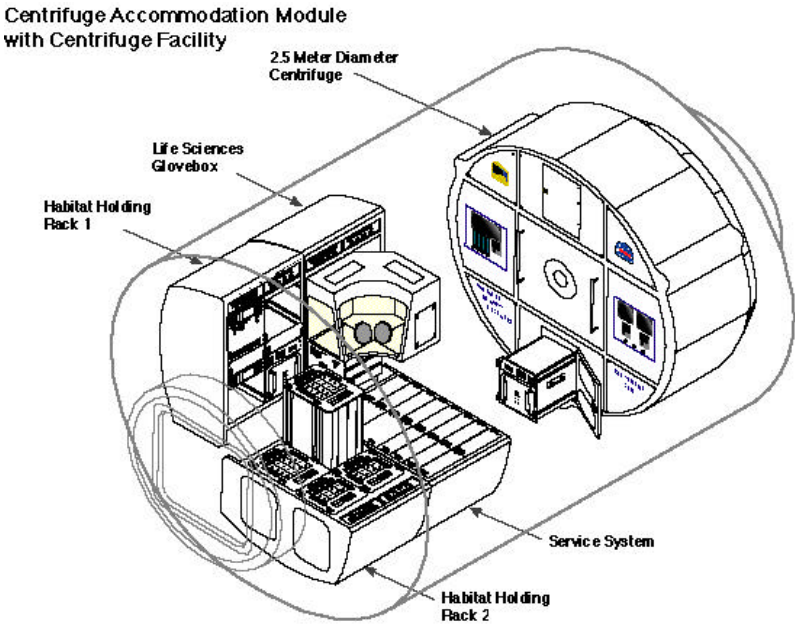
Gravitational Biology Facility and Centrifuge Facility on the International Space Station

The International Space Station will be an orbiting space facility that will include research laboratories and a crew habitation module. NASA and its international partners—the Russian, Japanese, European and Canadian space agencies—will build and deploy the Space Station beginning in 1998. International crews carried into orbit by the U.S. Space Shuttle and the Russian Soyuz will staff the Space Station on a permanent basis.

Gravitational Biology and Centrifuge Facilities

Two suites of equipment, called the Gravitational Biology Facility (GBF) and the Centrifuge Facility (CF), are being developed for use on the Space Station by the Space Station Biological Research Project at NASA/Ames Research Center at Moffett Field, California. These facilities will be used to conduct life sciences research on the effects of gravity, and its absence, on biological systems.





Scientific Objectives

Scientists associated with NASA's space biology program are attempting to understand the role of gravity in the biological processes of lower organisms, plants and animals. This will further our understanding of how

organisms are affected by, and adapt to, the space flight environment. The extended-duration studies possible with the Gravitational Biology and Centrifuge Facilities will build on knowledge gained from earlier life sciences missions and will allow scientists to continue investigating these important issues. Researchers will be able to study fundamental processes, such as biological development over successive generations, in the absence of gravity.

A quarter century of space life sciences missions has been conducted by both the American and Russian space agencies, yet much remains to be learned about the role of gravity in biological processes. Previous studies have identified, but not fully explained, the weakening of the cardiovascular and muscular systems, the alteration of blood chemistry, and the bone demineralization that result from exposure to space flight conditions. Continued human exploration of space requires that we understand why these changes occur.

Benefits

In addition to providing insight into the effects of space flight, the data generated by experiments in the Gravitational Biology Facility and the Centrifuge Facility may advance the quality of life here on Earth through applications in agriculture, biotechnology, environmental management, medicine and other human activities dependent upon biological resources. For example, many diseases affecting humans have symptoms similar to the deconditioning phenomena observed in astronauts and research animals as a result of space flight. A more complete understanding of these phenomena may help scientists develop better treatments for these diseases.

Because the research done in these facilities will increase our understanding of the effects of gravity on biological systems, it will help scientists design countermeasures to offset the effects of long-term exposure to zero gravity during space flight, and to partial gravity at future bases on the moon and Mars. The long operating period and unique capabilities of the Gravitational Biology and Centrifuge Facilities also will help researchers discover how different levels of gravity affect living systems, not only over the course of an organism's life span, but over multiple generations as well. This knowledge will be important if we are to establish permanent human installations in space or on the moon.

Gravitational Biology Facility

The Gravitational Biology Facility consists of habitats to support a variety of specimen types, ranging from cells and tissues to full size plants and mammals, plus a set of laboratory support equipment to be used for conducting experimental procedures on orbit.

Habitats

The facility consists of multiple habitats to support organisms for research in cell, developmental and plant biology. These habitats will provide food, water, light, air, humidity control, temperature control and waste management for the organisms. In addition to environmental capabilities, the habitats will be able to collect and transmit engineering and science data.

The Gravitational Biology Facility habitats include a Cell Culture Unit, an Aquatic Habitat, an Advanced Animal Habitat, a Plant Research Unit, an Insect Habitat and an Egg Incubator. The Cell Culture Unit will be used to support research in cell and tissue biology. It will have the capability to maintain and monitor microbial, animal, aquatic and plant cell and tissue cultures for up to 30 days. The Aquatic Habitat will accommodate small fresh water organisms, such as Zebrafish, for up to 90 days to support egg-to-egg generation studies for examination of all life stages. The Advanced Animal Habitat will be capable of housing up to six rats or a dozen mice. This habitat will be compatible with a compartment called the Mouse Development Insert. This Insert will accommodate pregnant mice, and subsequently their offspring, from birth through weaning. The Plant Research Unit will be able to support plant specimens up to 38 cm total height (root + shoot) through all stages of growth and development. The Insect Habitat will support *Drosophila melanagoster* (fruit flies) and other insects for multigenerational studies and for radiation biology. The Egg Incubator will support the incubation and development of small reptilian and avian eggs prior to hatching. All of the Gravitational Biology Facility habitats will have the experimental capability of selectable gravity levels. The Aquatic Habitat, Cell Culture Unit, Advanced Animal Habitat and Plant Research Unit will be used on the Centrifuge Facility's 2.5-meter-diameter centrifuge when selectable gravity levels of up to 2-g are needed. The Insect Habitat and Egg Incubator will be equipped with internal centrifuges that will provide selectable gravity levels from zero to 1.5-g.

Laboratory Support Equipment

The general purpose laboratory support equipment will include a -80°C freezer, a 4°C refrigerator, a cryo quick/snap freezer, a cryo storage freezer, passive dosimeter system, an incubator, a dissecting microscope and a compound microscope. This equipment will allow for sample preservation, sample manipulation and enhanced experimental capabilities aboard Space Station.

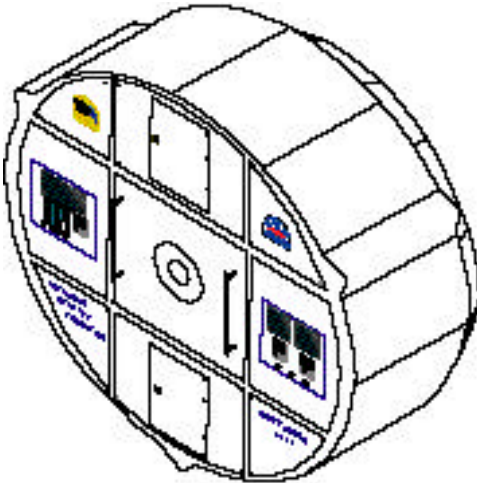
Centrifuge Facility

The Centrifuge Facility consists of a 2.5-meter centrifuge and two habitat holding racks to support habitats at artificial gravity levels and at the microgravity level of Space Station, respectively. In addition, the facility includes a glovebox to conduct experimental protocols and hardware maintenance, and a set of service system racks.

2.5-Meter-Diameter Centrifuge

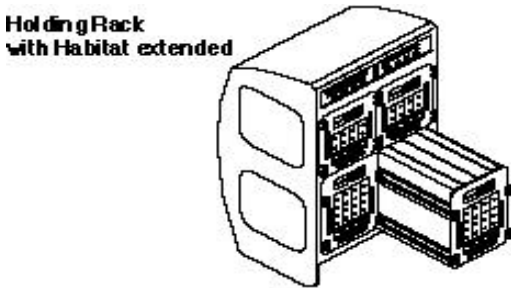
The Centrifuge will provide life support resources and electrical power to the habitats as well as data transfer links to computers on the Space Station. It is capable of producing controlled, artificial gravity levels ranging from 0.01-g to 2.0-g. Selectable gravity will permit scientists to compare how differing gravity levels affect the biology of organisms housed under otherwise identical conditions, thus separating the effects of gravity from other factors in the space environment. This also will allow a comparison between the effects of Earth's gravity and an equal force of artificially produced gravity. This type of experimental comparison is essential if scientists are to understand the effects of gravity on biological systems.

Comparison of living systems exposed to zero gravity with those exposed to the reduced or intermittent gravity levels attainable with the Centrifuge will help determine whether artificial gravity will be necessary during extended human missions into space. If artificial gravity is necessary, the Centrifuge will help researchers determine how long, and at what level, organisms must be exposed to artificial gravity in order to maintain health. Use of the Centrifuge will aid in the development of effective countermeasures to the effects of space flight evident in astronauts.



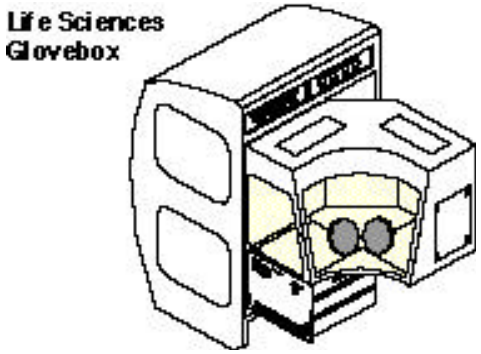
Holding Racks

The Holding Racks will provide life support resources and electrical power to the habitats and other scientific equipment, as well as data transfer links to computers on the Space Station. These data links will allow for data to be transferred from Space Station to Ames Research Center, twhich will relay it to scientists at their institutions and laboratories. This will allow researchers on the ground to monitor and control the environmental and experimental parameters inside the habitats. The arrangement of habitats in the racks will be reconfigurable, to allow the removal of equipment that is not being used and the insertion of equipment needed for specific experiments.



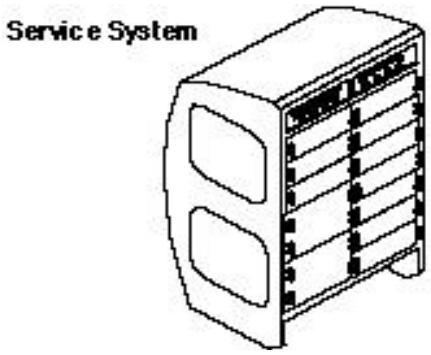
Life Sciences Glovebox

Habitats will attach to the Life Sciences Glovebox, which will provide an enclosed work space for performing experiments and handling research organisms. Two crew members will be able to use the Glovebox work space at the same time by means of gloves that extend into the work area. The enclosed volume of the Glovebox will be about one-half cubic meter (approximately 18 cubic feet). As air circulates through the work space, activated charcoal filters will continuously clean it by absorbing chemicals that may be present. In addition, a high-efficiency air filter will remove particles and aerosols.



Service System

The Service System consists of three racks. Two are essentially empty storage space for equipment and biologically active materials. The third will provide minimal electrical services for laboratory equipment, in addition to storage space.



Assembly and Operations

The assembly of Space Station begins in 1998 and will be on-going for five years until assembly is complete. The Gravitational Biology Facility and Centrifuge Facility will be brought up in phases beginning in 2001. Once the scientific equipment is on orbit, the Space Station crew will begin to perform life science experiments. The complexity of life science experiments will increase as more equipment is installed and more power becomes available. Space Shuttle flights to orbit will bring supplies to continue experiments and start new ones, as well as material to replace and upgrade equipment. Return flights will bring experimental samples back to Earth for analyses.

Conclusion

The Gravitational Biology and Centrifuge Facilities, by providing habitats, holding racks, a glovebox, a centrifuge and a service system, will support advanced, extended-duration space life sciences research aboard the International Space Station.

For further information on the Gravitational Biology and Centrifuge Facilities, please contact:

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